

Dealing with 100 years of tribal knowledge*

(*words stolen from Robert Beinefeld)

Plug-in Hybrid & Electric Vehicle Research Center
phev.ucdavis.edu



PH&EV Center Research teams and research partners



Consumers

- Lifestyle studies
- Market demand
- Usage patterns
- CEC, BMW, ARB

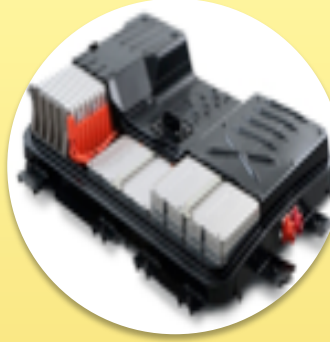
Dr. Kurani



Fleet Development

- Market Segments
- Fleet Operation
- Energy Savings
- Chrysler, DOE

Dr. Nesbitt



Battery studies

- Benchmark Testing
- 2nd use
- End of life
- DOE, NREL, Aerovironment, UCB, UCSD, SDGE

Dr. Burke



Spatial & Temporal PEV Energy Use

- GIS analysis
- Charging network design
- CEC, Nissan, INL, ECotality

Dr. Nicholas
& Dr. Tal



Human Machine Interfaces

- Response to HMI design
- Benchmarking
- ARB, ORNL, CEC

Dr. Stillwater



Beginning to compare regions & cities trying to make PEVs happen

1. Partnership:

International Energy Agency, Clean Energy Ministerial Electric Vehicle Initiative, (16 Energy Ministries), Clinton 40, Rocky Mountain Institute, PH&EV Center

2. WECE Website

20-24 cities, data sharing, project showcasing

3. WECE Conference

Los Angeles May 5 2012

Amsterdam, Shanghai, Stockholm, Barcelona, Lisbon, Shenzhen, Tokyo, Hamburg, Victoria, Portland, San Diego, Los Angeles

The screenshot shows the WECE (World EV Cities and Ecosystems) website. At the top is a navigation bar with links: CONTACT, LOGIN, a search bar (containing 'e.g. tax incentives'), and a main menu with HOME, ABOUT US, CITIES, DATA, PROJECTS, and EVENTS. The header features a city skyline image with the WECE logo and the text 'WORLD EV CITIES AND ECOSYSTEMS'. Below this is a tagline: 'A central location for EV Ready Cities' activities and progress across the globe'.

The main content area is divided into three columns under the heading 'OUR OBJECTIVES':

- 1. DATA VISUALIZATION:** Includes a line graph showing 'Incentive (\$)' from 1980 to 2010. The graph shows a general upward trend with some fluctuations, reaching approximately \$400 by 2010.
- 2. SOCIAL NETWORKING:** Features a diagram of blue human figures connected by arrows in a circular pattern, representing a network.
- 3. INNOVATIVE RESEARCH:** Shows a small white car with 'electric drive' written on its side.

Below these is the 'OUR LOCATIONS' section, which includes a world map with yellow dots indicating member cities. Text below the map states: 'WECE represents a partnership of dozens of cities worldwide. Click on the highlighted regions of the map to learn more information.'

On the right side of the page, there is a 'NEWS' section with a headline: 'WECE Conference May 5, 2012 Los Angeles, CA' and a 'Learn More' link. Below this is a 'JOIN OUR NEWSLETTER' section with a text input field and a 'SUBMIT' button. The text says: 'Enter your e-mail address to receive updates regarding WECE news, events, and projects. All contact information is kept confidential.'

The footer contains 'PARTNER ORGANIZATIONS' with logos for IEA (International Energy Agency), Clinton Foundation, UC Davis Plug-in Hybrid & Electric Vehicle Research Center, and Rocky Mountain Institute. At the very bottom, contact information is provided: 'CONTACT: turrentine@ucdavis.edu | Copyright WECE 2012'.

Automobility

- 100 year system of petroleum, internal combustion, roads.
- Important practical and lifestyle tool, mobility, public symbol of household success.
- 100 years of “tribal knowledge” of users, makers, etc..
- World total fleet 6-700 million / World Annual Sales 75 million
- Many brands, types, 100s of models, brutally competitive, big investments
- Slow turnover (10-15 years) –saturation and declining sales in US, Japan, Europe..first buyer sales in China, India, Eastern Europe, South America

Buyers are confronted with new, complex choices



Difficult choices



- **Driving range & refueling:**
 - PHEV dual fueled, 20-100 km of EV range, blended designs
 - BEVs – big range of ranges 50-300 km when full discharged
- **Electricity:** costs (\$.03-.30 kWh), dashboard displays, sounds; drive feel; plug in where they park,
- **Vehicle uncertainty:** safety, batteries, durability, cold and hot climates, will people think I'm smart?
- **Complex social & environmental benefits:**
 - Greatly reduce petroleum use;
 - Zero tailpipe for BEV,
 - GHG emissions vary by regions

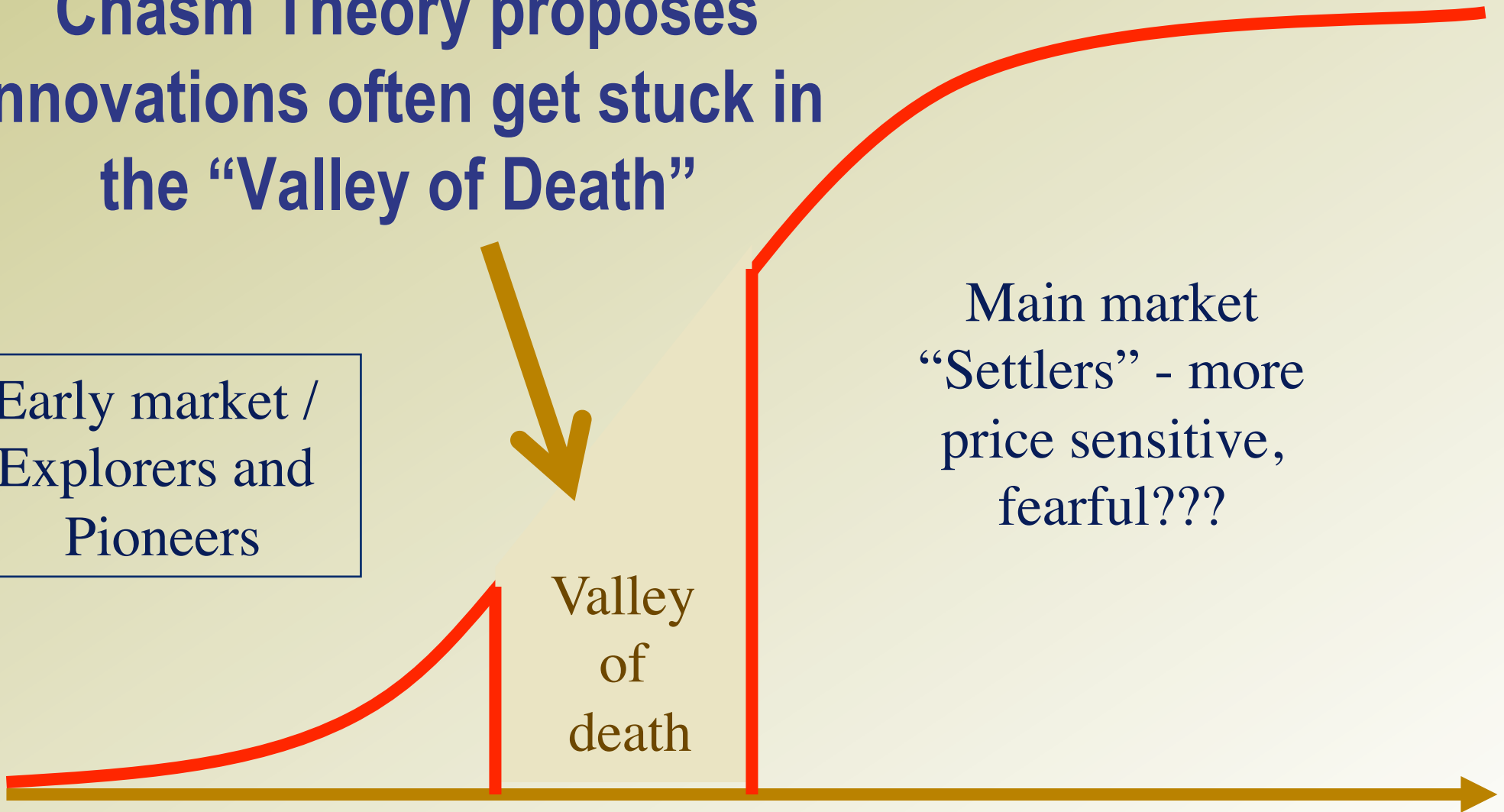
Chasm Theory proposes innovations often get stuck in the “Valley of Death”

Early market /
Explorers and
Pioneers

Valley
of
death

Main market
“Settlers” - more
price sensitive,
fearful???

Development of market

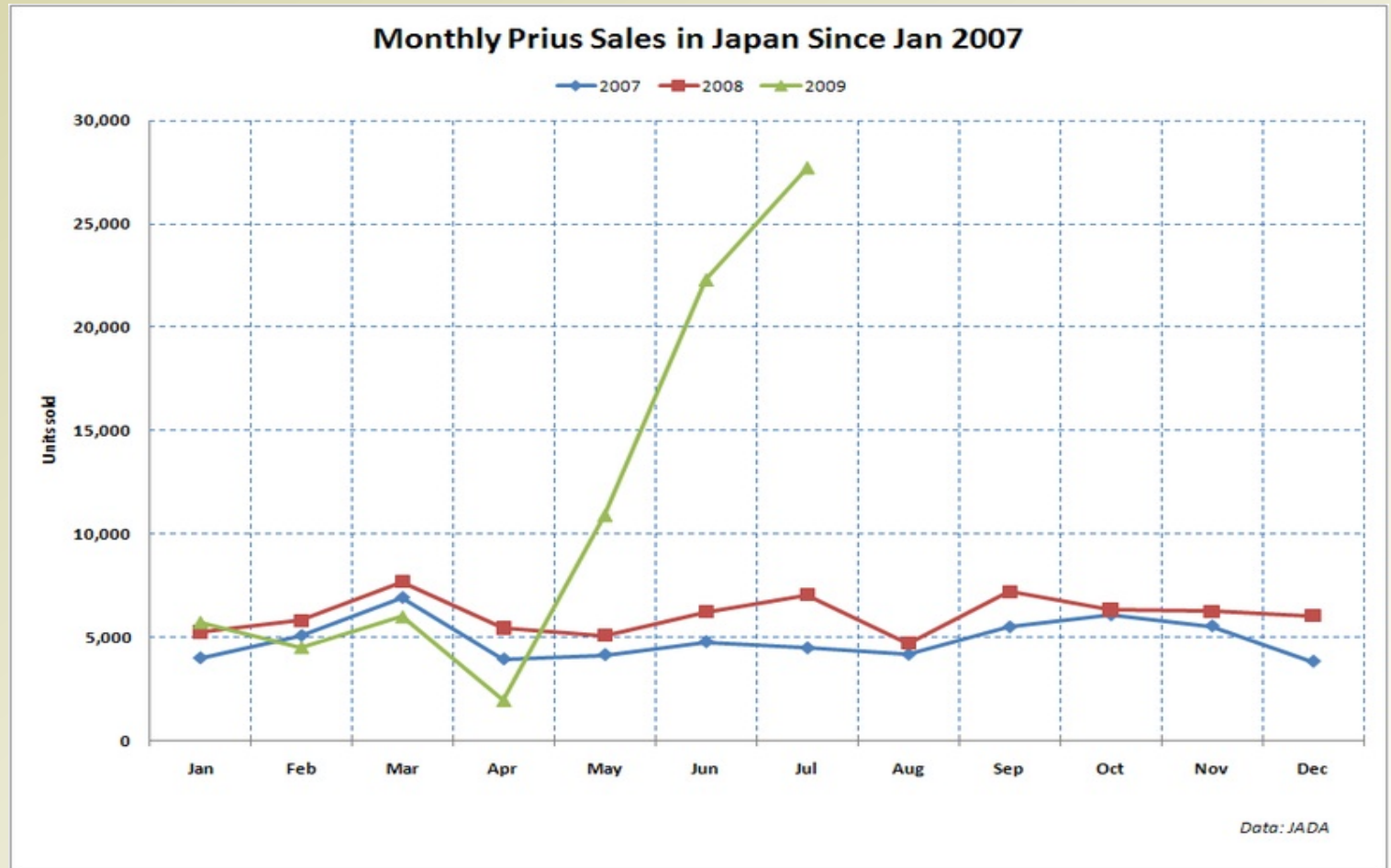


Did HEVs cross the chasm in Japan?

Why is the Prius the best selling vehicle in Japan?

(since 2009, 35,000-7% of sales in Feb 2011 20,500 12th in US)

- About \$100,000 yen/ \$1100 incentive
- Public values and knowledge were developed



Why are 50% of US Leaf & Volt sales in California/

- Price of vehicle is lower? More affluent?
- Price of gas is higher? Lower price of electricity?
- More incentives to buyers? (rebates, tax credits, HOV lanes, free electricity/ parking?)
- EV ready? (charge system in place?)
- Regulations? (ZEV program)
- Tree huggers..liberals..techies..
- 5 times as many innovators?

In 1090s, Tom and Ken study potential buyers of EVs, some buyers of CNG

- Tom & Ken ..1990s: focus on practical decisions of fleets, pioneers, probable buyers of CNG, diesel, EVs, PHEVs, about range, refuel/recharge, low speed EVs, “city “ EVs.

Concept of range elusive without direct experience, households talk about “critical” trips, routine activity space, safety buffers, main market is probably “hybrid households”

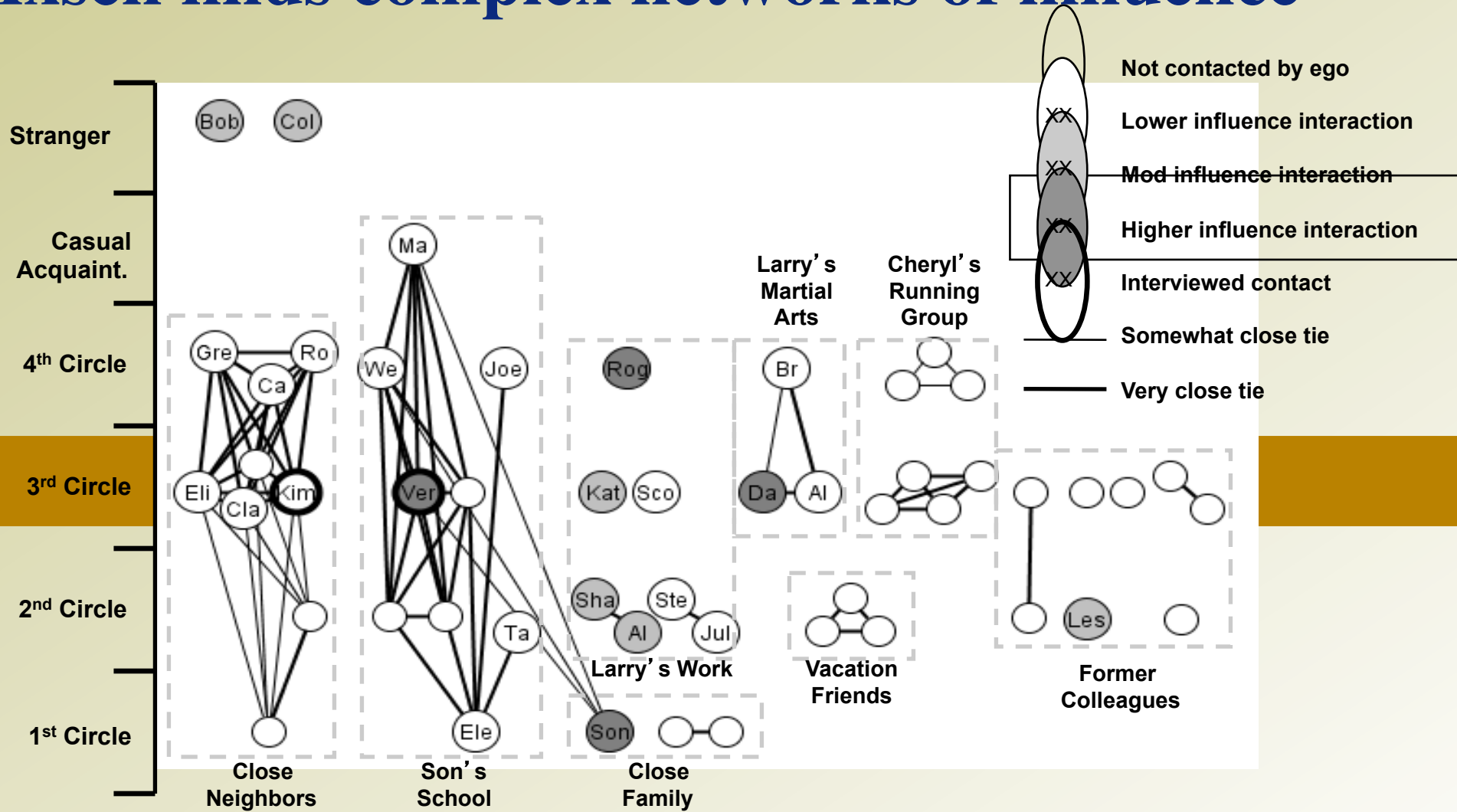
- Buyers not interested in CNG, Methanol unless it saves money.
- EV driving experience and concept of using electricity as fuel has some spark

ITS researchers finally learn about real decisions..

- **Heffner era-** HEV “purchases”
 - Buyers talk less about practical aspects. More about “meaning”
- **Ken and Tom -** Fuel economy decisions
 - No book keeping, no knowledge of annual fuel costs, focus on pump price and tank price
- **Axsen era** – AFVs and PEVs in social networks. Two concepts:
 - Liminality: openness to change (decisions in life context)
 - Translation: drivers fitting technology into their lives...
- **Kurani and team** – Focus on “narrative”,
 - the story driver’s construct to explain and direct their decisions...
- **Turrentine and team** – BMW MINI-E
 - “fun and clean”, “energy use mastery,” my EV space

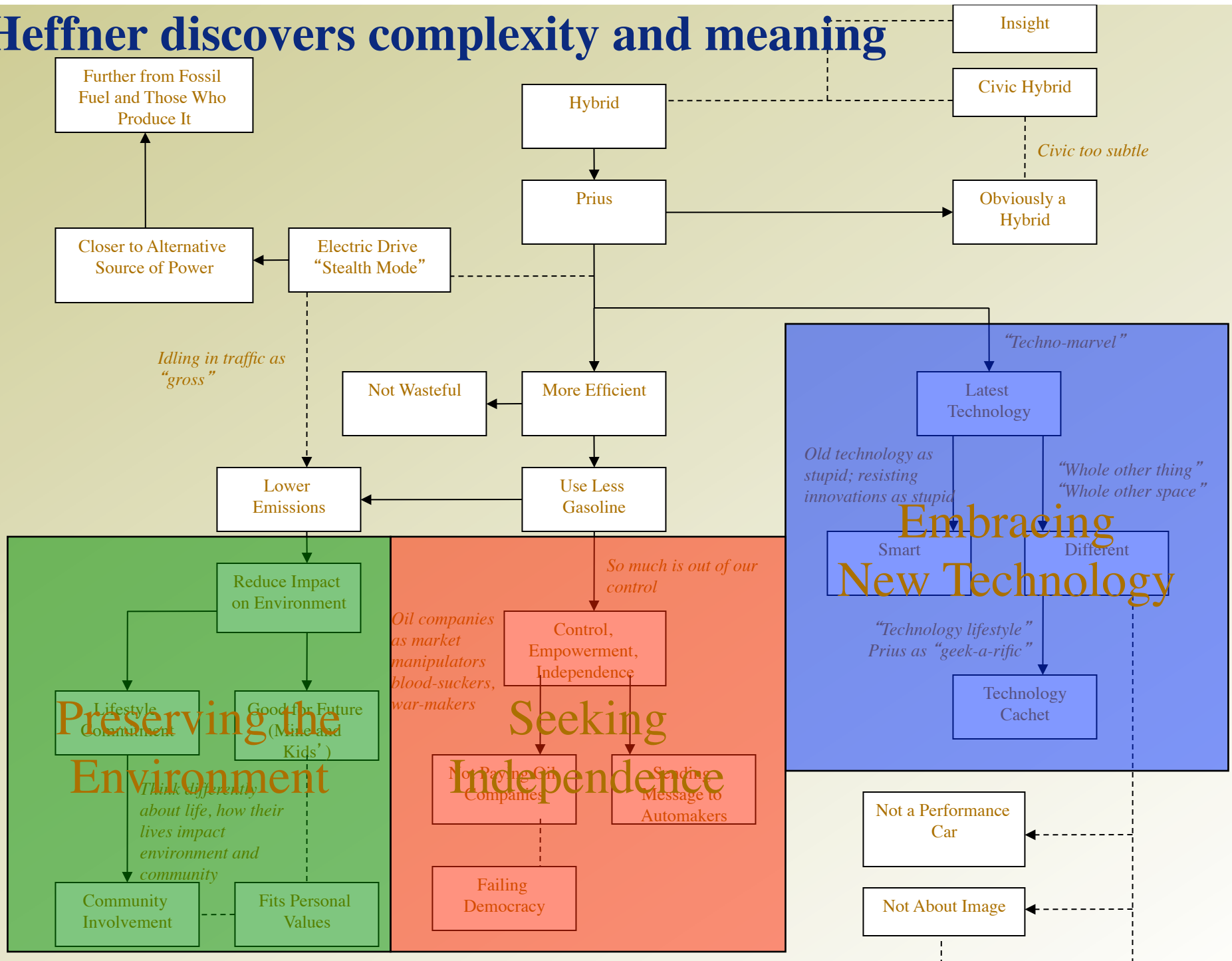
Axsen finds complex networks of influence

Social Proximity to the Rhodes



Larry and Cheryl Rhode

Heffner discovers complexity and meaning



We learned how households change driving patterns with Mini E.

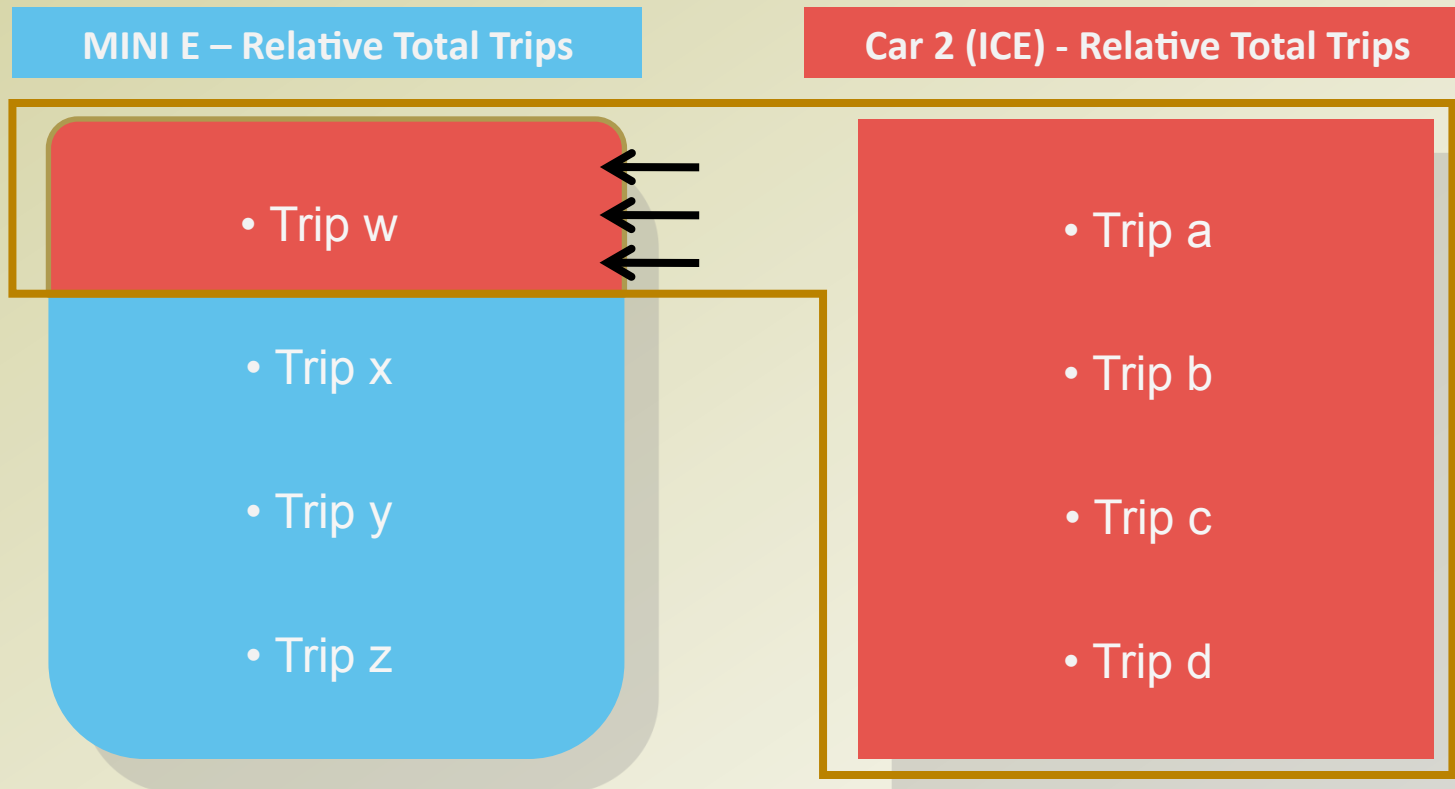
Car 1 (ICE) – Relative Total Trips

- Trip w
- Trip x
- Trip y
- Trip z

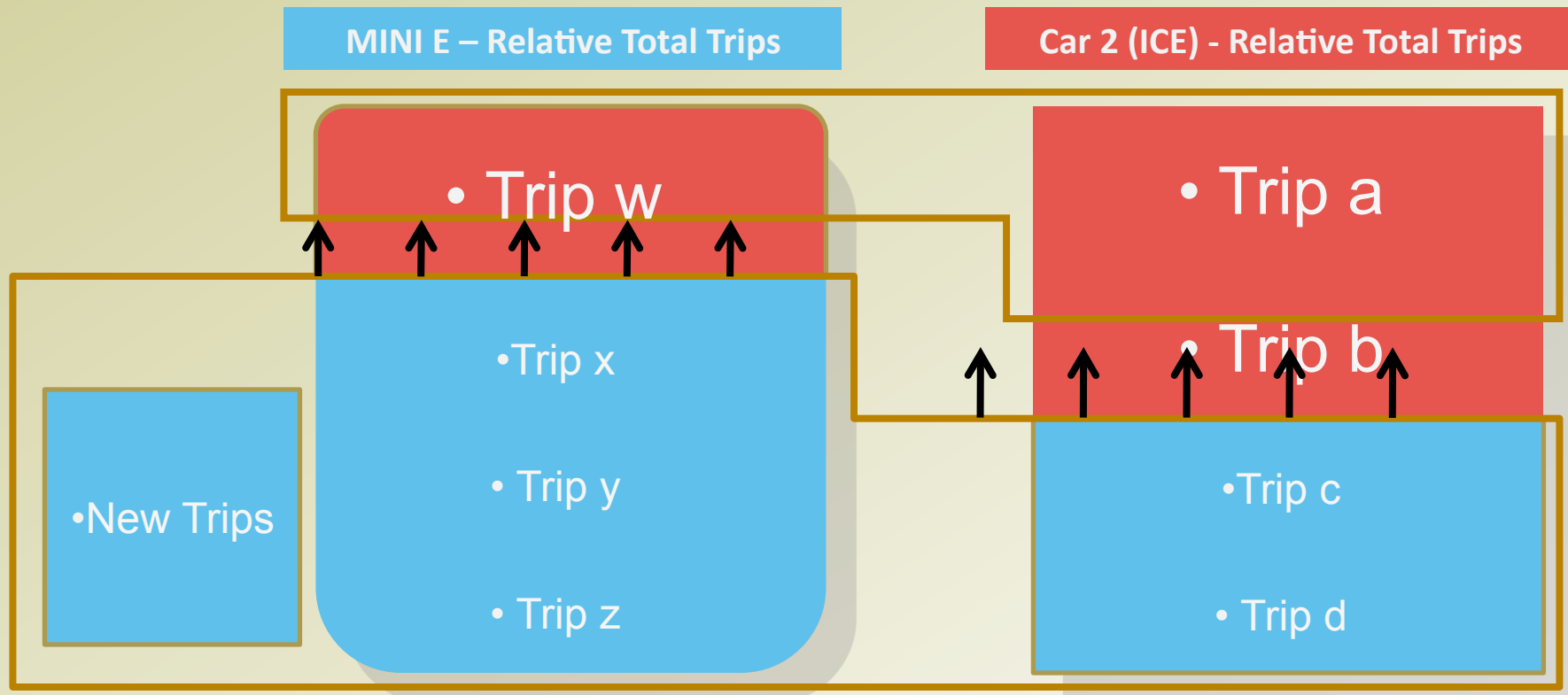
Car 2 (ICE) - Relative Total Trips

- Trip a
- Trip b
- Trip c
- Trip d

Longer trips shifted to Car 2



Some of Car 2 trips shifted to Mini E



Recent survey - Gil Tal, Mike Nicholas and team

- EV project in San-Diego (Ecotality)
- State rebate program (CCSE)

Response numbers:

Nissan Leaf	1076
Chevrolet Volt	32
Tesla Roadster	21
Total	1129 PEVs



Households Characteristics (based on an early subsample of 637)

- 96% live in single family House

- 95% own their house



- 42% have solar panels

- 18% consider installation

- 40% have no plan to install



- Average Household size 2.7

- 83% have yearly income higher than

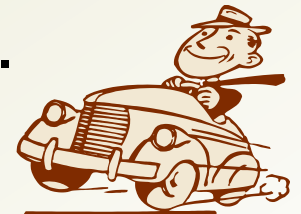
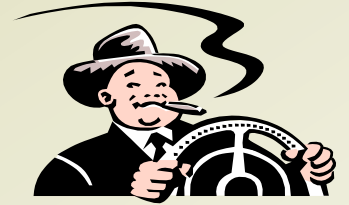
- 46% incomes is higher than \$150K

- 16% decline to state.



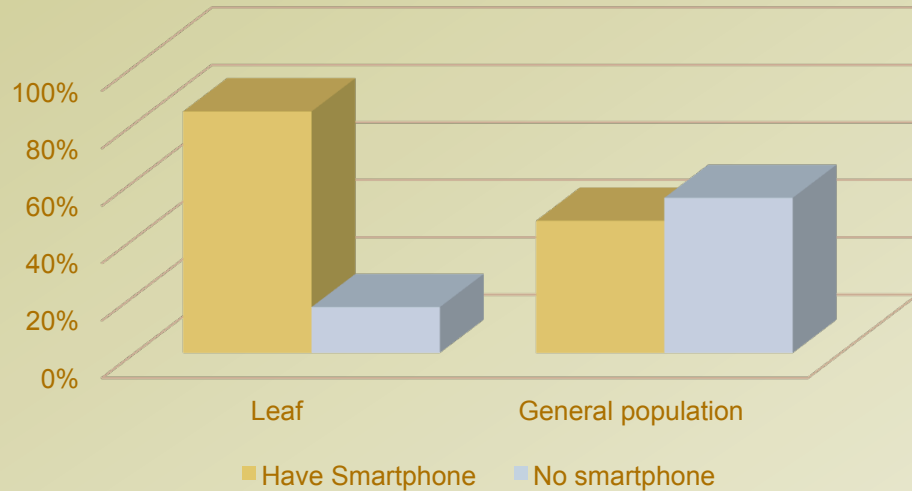
Average driver looks like Tom (with more money)

- Average age of a LEAF driver is 50 years old but *only 10% are over 65* (N=1003)
- In 80% of the households the main LEAF driver is Male.
- On average, the main driver is using the car 76% of the time.
- 22% of the vehicles are used by single driver.

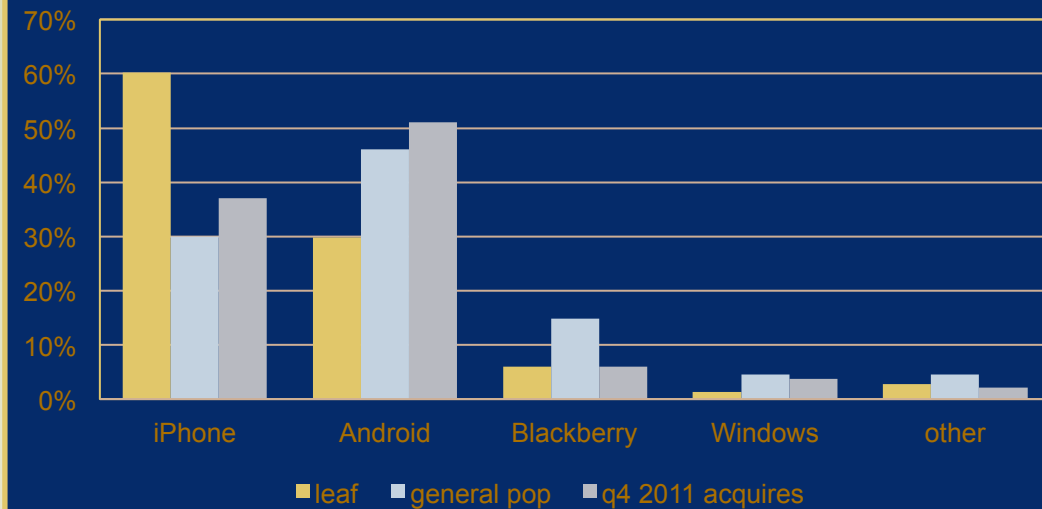


Leaf buyers have smart phones and techy stuff..

Have Smartphone



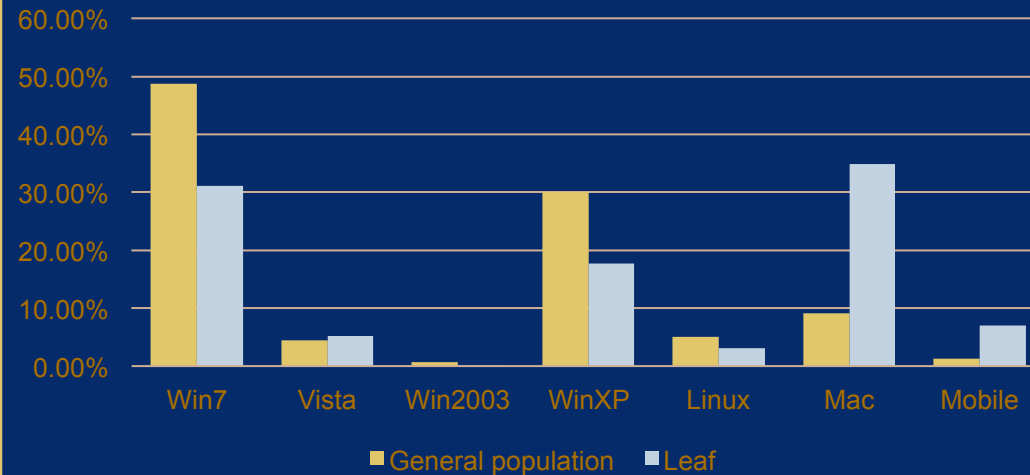
Smartphone OS



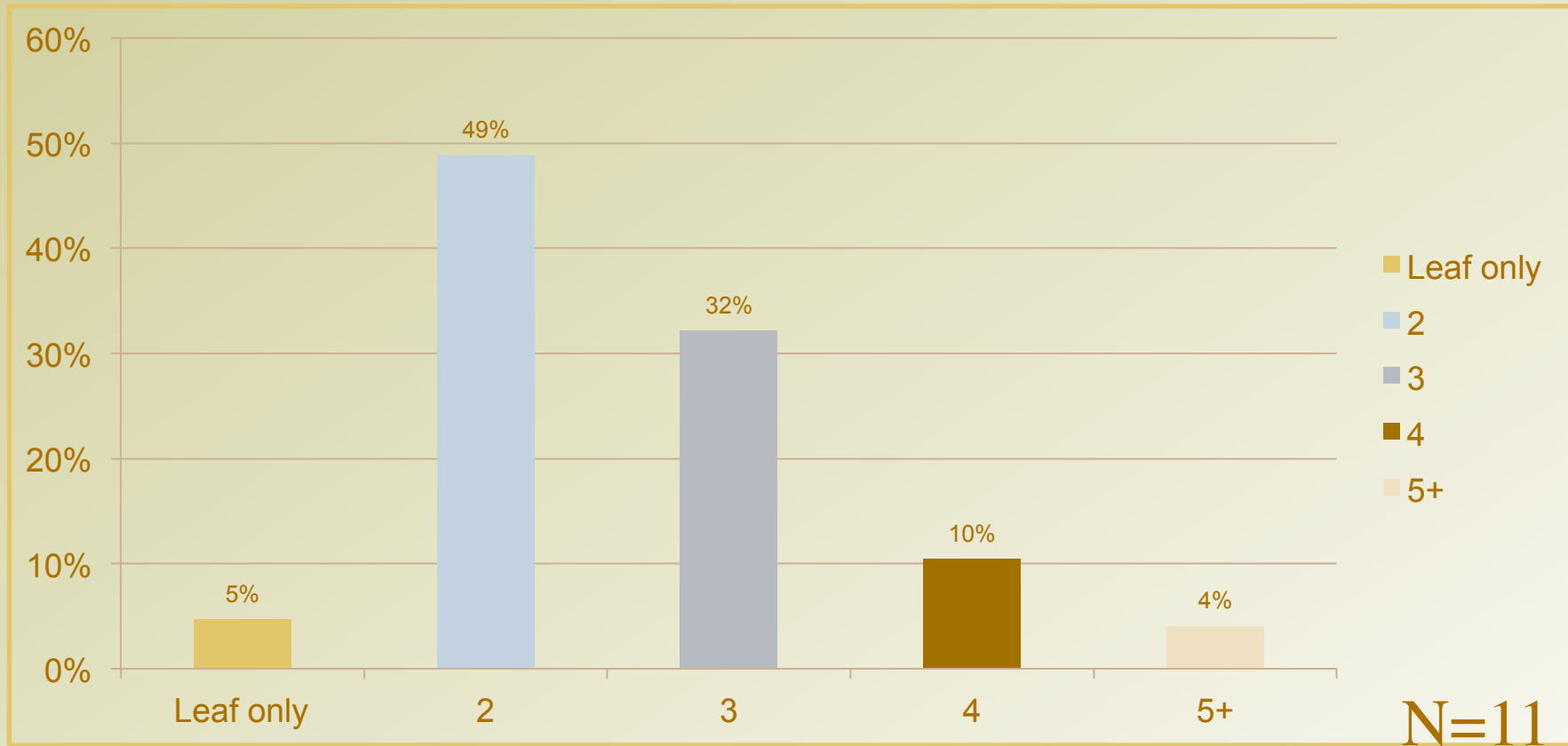
Leaf Owners Vs. General Population

- More Smartphones
- More iPhones
- Newer Computers
- More Macs

Computer OS



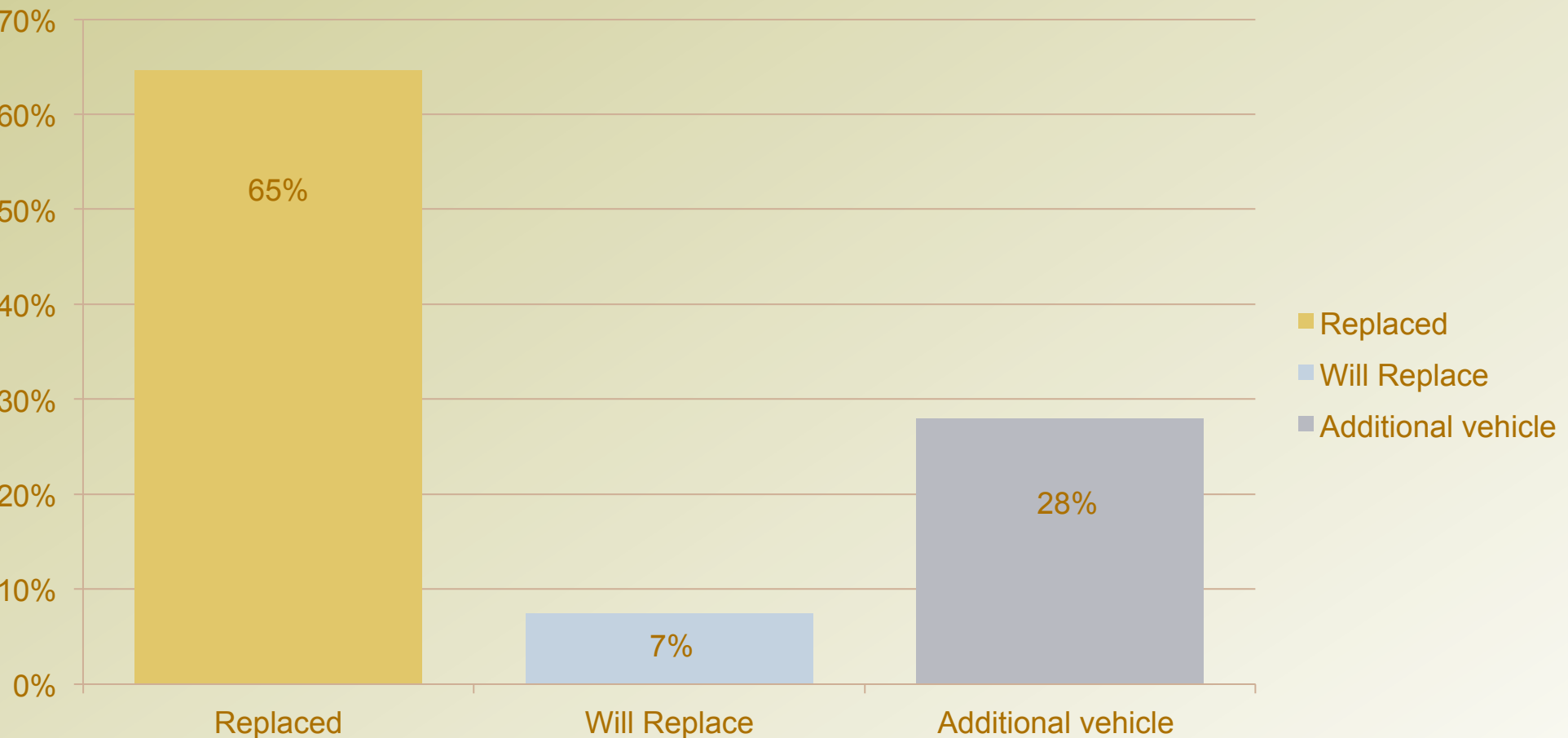
Households are combining HEVs and EVs



- 23.8% of the EV household also own a Hybrid. 15
- 9.1% of LEAF owner have another Nissan.

Household Fleet Changes with the LEAF

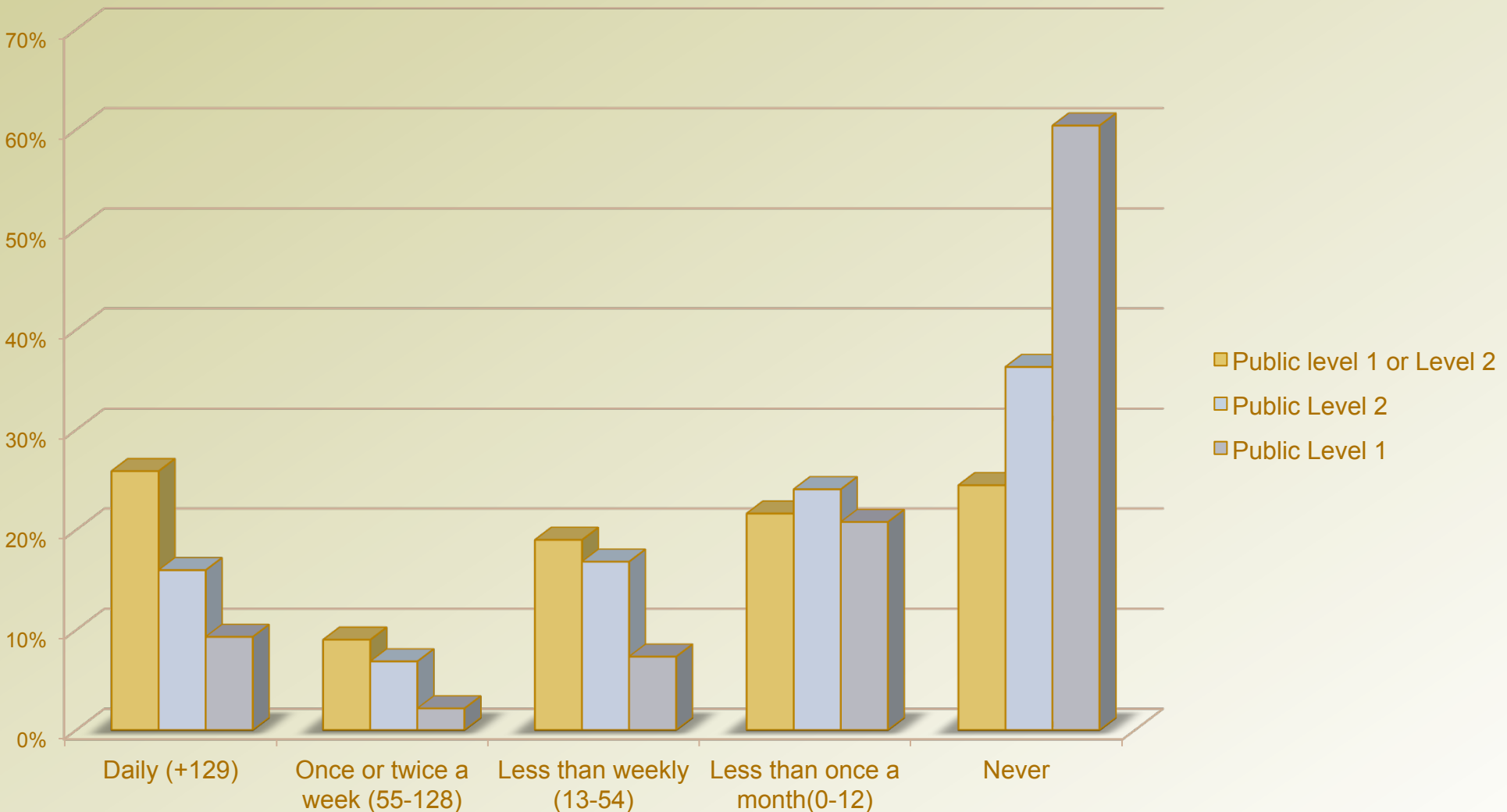
"Vehicle Change"



- 19.4% of the replaced vehicles are hybrid
 - But 35% of those have a second Hybrid in the household

Not using Level 2 very often

(has much to do with 3.3 kW charger in Leaf)



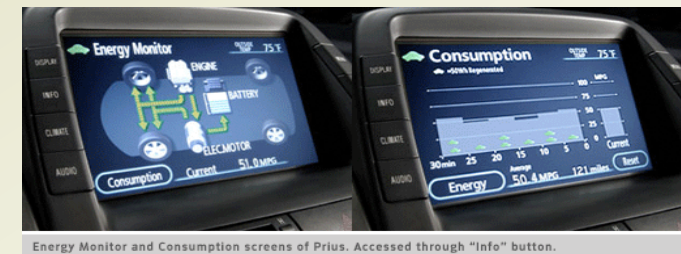
Most want DC fast charge

271 Respondents

	Charger 1	Charger 2	Charger 3	Charger 4	Charger 5	Total by Type
DC Fast	116	111	93	79	74	473
Level 2	66	37	32	24	17	176
Total Chargers	182	148	125	103	91	649

We are looking at energy feedback devices impact on driving and vehicle choices as well

- 2009 Scangauge field test (~6 drivers, 6 months).
- 2008-9 Prius field test with V2Green Gridpoint website (~60 households, 1 month each).
- 2009-10 UC Davis custom HMI (~40 drivers, 1 month each)



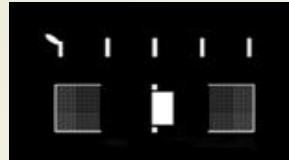

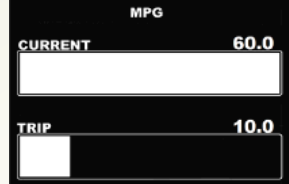
Energy Monitor and Consumption screens of Prius. Accessed through "Info" button.



Tai and Ken are studying hardware ...

- **Currently Running Large Sample (150 household) feedback test along the I-80 Corridor funded by ORNL/DOE**
 - Using the DashDAQ data display and logger
 - Custom screens test both the effect of “raw” information and contextual feedback
 - Direct test of 3 common designs



Screen Name	Operational Description	NHTSA Scores	NHTSA Name and Image
'Accelerator'	Instantaneous acceleration bar and trip-level leaf representation of fuel economy.	High comprehension, low load, high satisfaction, uncommon in application	CSO2 
'Shrubby'	Short term and trip-level leaf representations of fuel economy.	Moderate Comprehension, moderate load, high on satisfaction, uncommon application	CSO3 
'Numbers'	Instantaneous and trip-level fuel economy in horizontal bar format.	Moderate on comprehension, moderate load, low on satisfaction, common in application	CSO6 

And smart phone applications as well..

- **Smartphone-based feedback for a larger evaluation of multiple metrics and styles.**
 - Smartphone platform enables our lab to create intricate custom designs at a very low per-subject cost.
 - Currently finalizing funding from the ARB and the Bay area MTC (MPO) for a 750 participant study starting summer 2012.

